

REMARKS/ARGUMENTS

The action by the Examiner of this application, together with the cited references, have been given careful consideration. Following such consideration, claim 15 has been amended to more clearly define the patentable invention applicant believes is disclosed herein. Moreover, claims 32-34 have been newly added, and claims 19, 21, and 23-25 have been canceled. Claims 16-18, 20, 22 and 26-31 are unchanged by the present amendment paper. Claims 1-14 are presently withdrawn. This amendment is presented according to "Revised Amendment Practice" (37 C.F.R. 1.121), effective July 30, 2003. It is respectfully requested the Examiner reconsider the claims in their present form, together with the following comments, and allow the application. The present amendment is being filed along with an RCE.

The applicant's representative wished to thank the Examiner for the courtesy extended during the telephone interview held July 27, 2004.

The Examiner has rejected claims 15-18, 20, 22, 23 and 26-31 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In particular, the Examiner comments with respect to claim 15 on the limitation reciting "wherein said hydrochloric acid is in a range of 5 volume% to 95 volume%." It is noted by the Examiner that "[s]ince no concentration or weight% is provided for the acid, it cannot be determined how much acid is added to the etchant." Appropriate corrections have been made by amendment. The Examiner indicated during the telephone interview that the present amendment to claim 15 should overcome the 35 U.S.C. 112, second paragraph rejection. Accordingly, it is respectfully requested that the Examiner now withdraw the 35 U.S.C. 112, second paragraph rejection.

It should be appreciated that the present invention is generally directed to a resistive etching solution that results in increased etching rates in the case of high ratios of C_{SA}/R_{SA} , where C_{SA} is the surface area of copper exposed to the etching solution and R_{SA} is the surface area of Ni/Cr alloy exposed to the etching solution. The present invention also increases the etching rates in the cases where the etching spaces are small (i.e., less than about 2-6 mil wide).

The Examiner has rejected claims 15-18, 20, 22, 23 and 26-31 under 35 U.S.C. 103 as being unpatentable over admitted prior art in view of U.S. Patent No. 4,370,197 to Abolafia et al. and U.S. Patent No. 4,160,691 to Abolafia et al.

Independent claim 15 now includes the step of:

selectively etching the resistive layer including the *nickel-chromium alloy* with an etchant comprised of hydrochloric acid, glycerin and thiourea, wherein said glycerin is in a range of 5 volume% to 95 volume%, and said thiourea is in a *range of about 1 ppm to 200 ppm*. (emphasis added.)

Claim 15 now clearly defines the “resistive layer” as including a “nickel-chromium alloy having at least one of aluminum and silicon” and an etchant including thiourea in the range of about “1 ppm to 200 ppm.” It is respectfully submitted that these limitations clearly distinguish the claimed invention from the cited references, as will be discussed in detail below.

The Examiner argues that the admitted prior art discloses that it is known to form an embedded resistor from a resistive foil bonded to a dielectric layer, wherein the foil is comprised of a resistive material (a Ni/Cr alloy) on a copper foil. The Examiner further argues that the admitted prior art discloses that the foil is sequentially etched first with a copper etchant and then with an etching solution, to remove Ni/Cr without attacking the copper. Moreover, it is argued by the Examiner that the applicant admits that acidic chromium etching solutions are preferred for etching Ni/Cr alloys, and that one known solution for etching comprises hydrochloric acid and glycerin.

While it is acknowledged that the Background of the Invention discloses Acidic chromium etching solutions that can be used to etch a Ni/Cr alloy layer, it is also disclosed that it has been observed that the etching rate of solutions of the type heretofore described *decreases significantly as the following ratio increases*:

$$\frac{\text{the surface area of copper exposed to the etching solution } (C_{SA})}{\text{the surface area of Ni/Cr alloy exposed to the etching solution } (R_{SA})}$$

Furthermore, it is observed in the Background of the Invention that this ratio can reach a value wherein etching of the Ni/Cr alloy is *inhibited*. Moreover, it has been found that

some Ni/Cr alloy etching solutions may *dissolve treatments* (including, but not limited to, adhesion-promoting treatments (e.g., nodular treatments), thermal barrier layer treatments, stain proofing treatments, and resin resistant coating treatments) that are deposited on the copper surface to enhance the peel strength and shelf life of a resistive foil.

The present invention was developed in view of the foregoing problems. These problems were overcome by the use of thiourea in combination with hydrochloric acid and glycerin. It should be carefully noted that the claimed invention identifies a specific concentration range for the thiourea component, namely about 1 ppm to 200 ppm. Moreover, the resistive layer including a nickel-chromium alloy having at least one of aluminum or silicon.

Abolafia et al. '197 teaches a etching a *chromium layer* with an etching solution comprised of hydrochloric acid and thiourea. The amount of hydrochloric acid is about 1.5% to 20% by weight, and preferably usually 8% to 10% by weight. The amount of thiourea is about 1% to about 10% by weight, and preferably about 1% to about 3% by weight (see column 3, lines 55-58). It is respectfully submitted that thiourea at 1% by weight is equivalent to at least 10,000 ppm. In contrast, the amount of thiourea for the claimed invention is in a range of about 1 ppm to 200 ppm. Accordingly, the amount of thiourea as taught by Abolafia et al. '197 is far outside the range of thiourea of the claimed invention. Moreover, the etching solution of Abolafia et al. '197 is for etching chromium, whereas the etching solution of the present invention is for etching a Ni/Cr alloy having at least one of aluminum and silicon.

The Examiner acknowledges that Abolafia et al. '197 does not teach an etching composition comprising glycerin. Accordingly, the Examiner argues that Abolafia et al. '691 teaches a composition for selectively etching chromium comprising hydrochloric acid and glycerin. As indicated above with respect to Abolafia et al. '197, Abolafia et al. '691 discloses an etching solution for etching *chromium*, rather than a Ni/Cr alloy having *at least one of aluminum and silicon*.

The Examiner states that "[s]ince it is known in the art that acidic chromium etching solutions are preferred for etching Ni/Cr alloys, and that a solution comprising hydrochloric acid and thiourea is suitable for etching a chromium layer without attacking an adjacent copper layer, one of ordinary skill in the art would have been motivated at the time of the invention to use an etching solution comprising hydrochloric acid and thiourea to remove the

Ni/Cr layer of the resistive foil in order to etch a Ni/Cr layer without significantly etching an adjacent copper layer.”

It is respectfully submitted that combining hydrochloric acid in the quantity disclosed by Abolafia et al. '197 (i.e., about 1.5% to 20% by weight) with the quantity of thiourea disclosed by Abolafia et al. '197 (i.e., about 1% to about 3% by weight, equivalent to at least 10,000 ppm) would also etch the copper. In fact, the example provided in Abolafia et al. '197 identifies an etch solution comprised of 50 ml of concentrated *sulphuric acid* and about 20g of thiourea in about 1L of water. Abolafia et al. points out at column 3, lines 29-33 that “[o]ne particular advantage of the present invention is that the present invention makes it possible to provide an etchant composition for chromium which *does not require hydrochloric acid*.” (emphasis added.) The quantities of hydrochloric acid and thiourea of the claimed invention have been selected to etch only the Ni/Cr alloy, and not the copper.

The Examiner indicated, during the telephone interview, that he would give careful consideration to Affidavits explaining the results obtained with thiourea within the claimed concentration range, and the problems identified with use of prior art solutions disclosed by Abolafia et al. '197 and Abolafia et al. '691. Accordingly, an Affidavit under 37 C.F.R. 1.132 is submitted herewith for consideration.

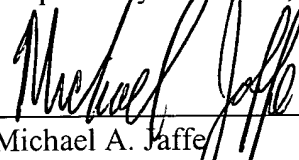
In view of the foregoing arguments and the affidavit submitted herewith, it is respectfully submitted that independent claim 15 is patentable over the cited references.

Claims 16-18, 20, 22-23 and 26-31 depend from claim 15, thus it is respectfully submitted that these claims are patentable over the cited references for at least the reasons set forth above in connection with independent claim 15.

In view of the foregoing, it is respectfully submitted that the present application is now in proper condition for allowance. If the Examiner believes there are any further matters which need to be discussed in order to expedite the prosecution of the present application, the Examiner is invited to contact the undersigned.

If there are any fees necessitated by the foregoing communication, please charge such fees to our Deposit Account No. 50-0537, referencing our Docket No. GD7345US.

Respectfully submitted,



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I hereby certify that this correspondence (along with any paper referenced as being attached or enclosed) is being deposited on the below date with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to Mail Stop Amendment, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Date: September 8, 2004



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